first time, in so far as we know, isotopic HI broadening of the x-ray K line. The experimental value agrees with the theoretical one.

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POWERFUL STIMULATED RADIATION IN RUBIDIUM VAPOR IN EXCITATION OF A LASER WITH ADJUSTABLE FREQUENCY

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In [1 - 5] stimulated emission from a number of levels of potassium was produced by irradiating potassium vapor with a pulse from a Q-switched ruby laser and by the Stokes SRS component excited by the same pulse in nitrobenzene. In the present study we have obtained powerful directed emission in rubidium vapor at frequencies close to the transitions $5^2S_{1/2}$ - $6^2P_{3/2}$ (4202 Å) and $5^2S_{1/2}$ - $6^2P_{1/2}$ (4215 Å), and also less intense directed radiation at the resonant rubidium lines $5^2S_{1/2}$ - $5^2P_{3/2}$ (7800 Å) and $5^2S_{1/2}$ - $5^2P_{1/2}$ (7047 Å), see Fig. 1. The use of a laser with tunable frequency has made it possible to investigate the dependence of the threshold of the directed radiation on the frequency of the exciting radiation.

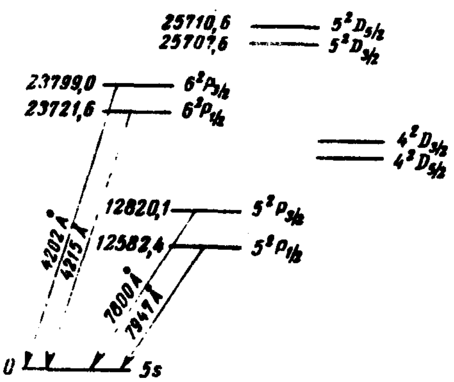

Fig. 1. Rubidium term scheme.

We used an organic-dye laser excited by a giant pulse from a ruby laser. Smooth variation of the wavelength in the range 7730 - 7900 Å was effected with the aid of the diffraction grating. The duration of the pulse at half-height was ~50 nsec, and the generation spectral line width was ~4 Å. The dye-laser radiation passed through a telescopic system which decreased the beam cross section to 2 - 3 mm and was incident on a cell with rubidium vapor, 15 cm long. The rubidium vapor pressure ranged from 0.001 to 1.2 mm Hg. The spectrum of the directed radiation was investigated with the aid of a spectrograph located a considerable distance away from the cell.

It was established that the minimum threshold of the appearance of directed radiation is reached with double the frequency of the exciting radiation is close to the frequencies of the two-photon transitions from the ground state to the levels $5^2D_{3/2,\ 5/2}$. A spectrogram of this radiation is shown in Fig. 2a. The principal part of the directed-radiation power is concentrated in the 4202 Å line. The 4215 Å line is much weaker and is characterized by a higher excitation threshold. The total radiation power of the violet lines reached ~1 kW at a pulse duration somewhat lower than the duration of the exciting pulse. The violet-line radiation is linearly polarized in a plane that coincides with the polarization plane of the exciting radiation.

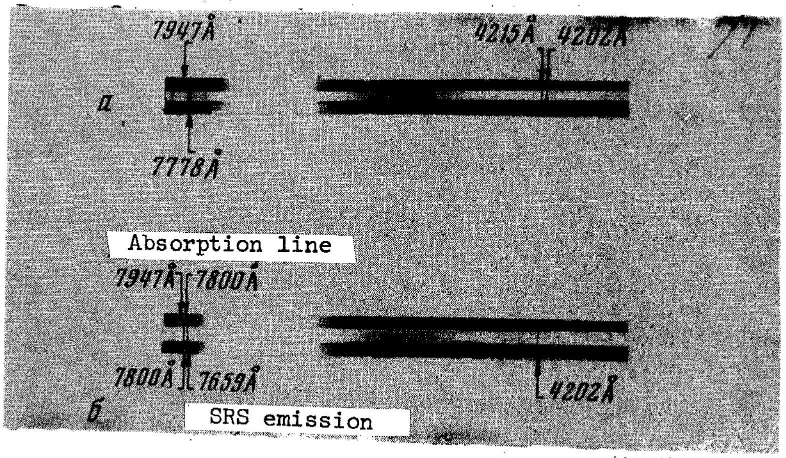

Fig. 2. Spectrogram of rubidium-vapor emission: a) exciting radiation wavelength 7778 Å, b) exciting radiation wavelength 7800 Å. The absorption spectrum of rubidium is shown for comparison.

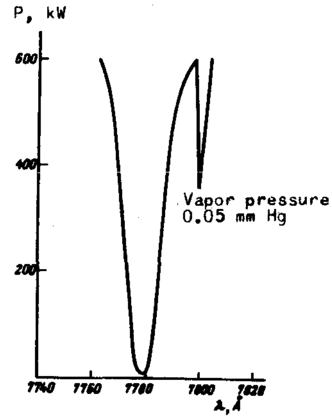

Fig. 3. Plot of the threshold of the exciting radiation.

Figure 3 shows the dependence of the threshold excitation power of the 4202 Å line on the wavelength of the dye laser, at a rubidium vapor pressure 0.05 mm Hg. The curve has a minimum near 7778 Å, which corresponds to two-photon resonance for the transitions $5^2S_{1/2} - 5^2D_{3/2,\ 5/2}$. A decrease of the threshold was observed also at 7800 Å corresponding to the transition $5^2S_{1/2} - 5^2P_{3/2}$.

In most spectrograms, the 4202 and 4215 Å lines reveal a shift in the red direction of the spectrum, amounting from fractions of a cm^{-1} to ~1.5 cm^{-1}. Many spectrograms obtained at high rubidium vapor pressure showed a shift of the lines towards the violet side of the spectrum. At a small shift there is a sharp dip at the center of the line, corresponding to the frequency of the atomic transition, or shifted slightly towards the red side of the spectrum. The line width ranges from a fraction of a cm^{-1} to ~1 cm^{-1}. In all cases the shifts and the widths of the 4202 and 4215 Å lines are the same.

The directional radiation of the rubidium lines is brought about apparently by population inversion of the 6P and 5P levels relative to the ground state. Inversion can be attained in the presence of an appreciable population of the 5D levels, which can occur as a result of two-photon absorption of the exciting radiation. In this case the population of the 6P and 5P levels is first due to the induced transitions[1]), and then, after equalization of the populations, to the spontaneous transitions from the 5D levels. The population inversion should be produced in this case first for the 6P levels, since there is a higher probability of transition from the 5D levels to these levels than to the 5P levels. The second minimum at the excitation wavelength 7800 Å (see Fig. 3) can be due to an increase in the probability of the two-photon transition near the single-photon resonance $5^2S_{1/2} - 5^2P_{3/2}$, and also to the increase of the role of SRS from the $5^2P_{3/2}$ level, as a result of the effective population of this level. We note that in this case there was observed an intense anti-Stokes SRS, connected with the transition of the atom from the $5^2P_{3/2}$ level to the $5^2P_{1/2}$ level (see Fig. 2b). Owing to the effective level $5^2P_{3/2}$, the excitation of the electronic SRS is possible at rubidium vapor pressures ~0.05 mm Hg (exciting-radiation intensity 2 MW/cm²).

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SCATTERING OF LIGHT BY A PERIODIC STRUCTURE OF EXCITED AND UNEXCITED ATOMS

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In connection with the development of applied holography, great importance attaches to low-delay recording and reconstruction of wave fronts of light. However, the presently available holographic receivers have large time lags, owing to the appreciable time interval between the final stages of the holographic process. Therefore great interest attaches to the possibility of reducing this interval by using the phenomenon of resonant absorption in substances with small relaxation times. By transferring the atoms from the lower state of the resonant transition to the upper one it is possible to produce a spatial distribution of the absorption coefficient.

This can be experimentally realized, for example, in the particular case when a resonator is placed in a medium at the point of intersection of two beams of coherent light $E_1 \exp\{i(\omega t - \vec{k}_1\cdot\vec{r})\}$ and $E_2 \exp\{i(\omega t - \vec{k}_2\cdot\vec{r})\}$ with plane fronts and with wave vectors $\vec{k}_1$ and $\vec{k}_2$. The time-averaged value of the spectral density of the radiation at the point of intersection of the beams will have the form, as a result of interference,

$$\rho_\nu = \frac{\epsilon}{8\pi}[(E_1^2 + E_2^2) + E_1E_2\exp\{-i(\mathbf{k}_2-\mathbf{k}_1)\mathbf{r}\} + E_1E_2\exp\{i(\mathbf{k}_2-\mathbf{k}_1)\mathbf{r}\}], \quad (1)$$

where ε is the dielectric constant of the medium. To find the dependence of the absorption coefficient on ρ_ν, we use a probability method of calculating the

[1]) A contribution to the population of the 6P levels may also be made by SRS from the $5^2P_{3/2}$ level.